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Can Characteristics of a Health Care System Mitigate Ethnic Bias in Access to Cardiovascular Procedures? Experience From the Military Health Services System

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Objectives. **This study sought to investigate the independent effect of ethnicity on the utilization of invasive cardiac procedures after acute myocardial infarction (AMI).**

Background. **The precise role of ethnicity in access to cardiovascular procedures is unknown, particularly because of difficulty in isolating ethnicity from financial and other socioeconomic factors. We conducted a retrospective analysis of the use of cardiac catheterization and coronary revascularization procedures after AMI in military health care beneficiaries. The Military Health Services System (MHSS) ensures equal access to care in an environment without financial incentives for procedural utilization; furthermore, socioeconomic differences between patients beyond ethnicity are minimized.**

Methods. **Data were analyzed from the Civilian External Peer Review Program representing abstracted chart reviews from 125 military health care facilities worldwide for all patients (1,208 white; 233 nonwhite [155 black]) with the principal or secondary diagnosis of AMI from March to September 1993.**

Results. **Rates of cardiac catheterization were similar in white and nonwhite patients (34.8 vs. 39.1%, p = 0.21). After controlling for age, gender, cardiovascular risk factors and AMI variables, including infarct size and other risk markers, there were no differences in the use of this procedure during the AMI admission in comparisons of white versus nonwhite patients (estimated odds ratio [OR] 0.96, 95% confidence interval [CI] 0.69 to 1.34) and white versus black patients (OR 1.19, 95% CI 0.80 to 1.78). However, white patients were significantly more likely than nonwhite patients to be "considered" for future cardiac catheterization (OR 1.77, 95% CI 1.19 to 2.61). Coronary revascularization within 180 days was not significantly affected by race in white versus nonwhite (OR 0.90, 95% CI 0.59 to 1.39) and white versus black patients (OR 1.11, 95% CI 0.65 to 1.89). Outcomes (30- and 180-day mortality and readmission rates) were similar for all race groups.**

Conclusions. **There is a limited relation between ethnicity and the use of invasive cardiac procedures in the MHSS. These data raise the promise that characteristics of a health care system can mitigate ethnic bias in medicine.**

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The relation between race and access to invasive cardiovascular procedures has been examined in multiple studies over the past three decades (1–11). These studies have uniformly identified racial bias in the access to a variety of cardiovascular procedures, including cardiac catheterization, percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass graft surgery (CABG). In general, white patients have been described to be 1.3 to 4.5 times as likely to undergo these procedures as nonwhite (principally black) patients. Disappointingly, despite the identification of potential racial bias and efforts to increase awareness of this problem within the medical community over this period, even recent studies continue to show this disturbing finding (8–12).

Over the same three decades, there has been an ongoing debate regarding the etiology of racial bias in medicine, particularly with respect to cardiovascular procedures. At the core of this debate is the implication that bias in the access to cardiovascular procedures is a matter of race, specifically by racial bias against nonwhite individuals. Beyond this presumption, the search for other possible causes has been inconclusive to date due to either limitations of existing studies or the possibility of other postulated, yet difficult to measure factors. These include local biases arising from data generated from a single center or region, an inability to adequately control for economic factors, differences in medical training or practice

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Abbreviations and Acronyms

AMI	=	acute myocardial infarction
CABG	=	coronary artery bypass graft surgery
CEPRP	=	Civilian External Peer Review Program
CHAMPUS	=	Civilian Health and Medical Program of the Uniformed Services
CK	=	creatine kinase
DRGs	=	diagnosis-related groups
MHSS	=	Military Health Services System
NHDS	=	National Hospital Discharge Survey
PTCA	=	percutaneous transluminal coronary angioplasty
VAMS	=	Veterans Affairs Medical System

patterns, differences in the level of insurance, remunerative concerns of practitioners, limitations in the amount of clinical data in predominantly administrative databases and patient perceptions on acceptance of invasive procedures (12). Thus, it remains unclear whether race or other factors are important determinants of the observed differential access to care in white and nonwhite patients.

The Military Health Services System (MHSS) currently serves approximately 9 million beneficiaries, including active duty military personnel, their dependents and retirees, and tracks demographic, diagnostic and procedural data from inpatient admissions in the 125 military treatment facilities worldwide. Although data from the MHSS share many of the strengths of administrative datasets, such as those created by the Veterans Affairs Medical System (VAMS) and Medicare, the MHSS database has a number of potential advantages over civilian systems, including a personnel system that can track patients accurately over time and space; excellent socioeconomic adjusters through the recording of sponsor rank; a broad representation of patient demography in terms of age, gender and location; and the absence of economic barriers and remunerative incentives to influence coding procedures. Thus, the characteristics of the MHSS address many of the limitations of past studies on the issue of ethnic bias in access to invasive cardiac procedures. Accordingly, we conducted a retrospective analysis of this issue in military health care beneficiaries after acute myocardial infarction (AMI). We hypothesized that within the MHSS, specific characteristics of the health care system, including health care access that is equal and ensured as a right of beneficiary status and limited socioeconomic differences between patients, would nullify an independent association of race and the utilization of invasive cardiovascular procedures.

Methods

Patient selection. In 1986 the Department of Defense initiated the Civilian External Peer Review Program (CEPRP) to provide external oversight of the care provided through the MHSS (13). The CEPRP focused on specific, predefined surgical, procedural and medical diagnoses; initiated chart abstractions of comprehensive, date-defined patient samples; and analyzed the standards of care in the MHSS compared with civilian norms. In the area of cardiovascular medicine, the CEPRP was tasked to specifically examine the use of cardiac catheterization and coronary artery revascularization procedures after AMI.

Among the activities of the CEPRP was an assessment of care for patients with AMI. Charts of all patients (n = 1,441) discharged from military treatment facilities with a diagnosis of AMI during the period from March to September 1993 were studied. After confirmation of the diagnosis of AMI based on elevation of total creatine kinase (CK) levels >200 U/ml and MB bands above the stated normal for the medical treatment facility under review, charts were abstracted by professional nurse abstractors for relevant clinical and demographic information. In 10 cases, clinical data were missing altogether (e.g., there were no procedures coded from the chart abstraction), and these were excluded from the analysis.

Demographic and clinical data. The data elements abstracted included patient demographics, including gender, age, race (coded as white, black, Asian, American Indian, hispanic or multiracial), military affiliation, beneficiary status (active duty, dependent or retired) and military rank of the sponsor (providing a measure of relative social, educational and economic status). Race was determined from the self-reported race, as listed in the Defense Eligibility and Enrollment System. Ethnicity was analyzed as white versus black race and white versus nonblack ethnic origin (12). Hispanics were grouped under the category of nonblack ethnic origin. The beneficiary status of the study group included 90 active duty military personnel (6.2%), 38 dependents of active duty military personnel (2.6%), 331 retired service members (23.0%), 915 dependents of retired service members (63.5%) and 67 other (4.6%) (including foreign diplomats). Military rank was used as a surrogate for socioeconomic status and educational level and was considered both a binary variable of income of ≥$30,000/year or <$30,000/year and as a categoric variable in $5,000/year increments.

The clinical data collected included the presence of cardiac risk factors, such as diabetes, hypercholesterolemia, hypertension, tobacco use and previous AMI. Clinical data relevant to the admission for AMI included the presence and duration of chest pain, electrocardiographic abnormalities, use of thrombolytic agents, blood pressure, peak CK value, ventricular arrhythmias, atrioventricular conduction block (Mobitz II or third degree) and congestive heart failure. Data on the post-AMI evaluation included the performance and ability to undergo stress testing and the performance and timing of cardiac catheterization, PTCA and CABG. Cardiac catheterization was coded as either performed during the hospital period or being considered to be performed within the subsequent 3 months. This group, for whom a chart notation to consider possible cardiac catheterization or future planned cardiac catheterization was made, represents a subgroup unique to this dataset.

Procedural and outcome data. Outcome variables coded included length of hospital stay and in-hospital mortality. To

Table 1. Clinical Characteristics of the Study Patients

	White (n = 1208)	Black (n = 155)	Other (n = 78)
Age (yr)	63.1 ± 11.1	57.7 ± 12.7*	60.6 ± 12.1*
Male gender	894 (74.0)	111 (71.6)	53 (68.0)
Hypertension	550 (45.5)	104 (67.1)*	36 (46.2)
Diabetes mellitus	305 (25.2)	43 (27.7)	26 (33.3)
Hypercholesterolemia	269 (22.3)	35 (22.6)	19 (24.4)
Tobacco use	101 (8.4)	12 (7.7)	4 (5.1)
Previous myocardial infarction	78 (6.5)	7 (4.5)	7 (9.0)
Hospital period variables			
Thrombolytic therapy	282 (23.3)	37 (23.9)	18 (23.1)
Peak creatine kinase (U/liter)	1,038 ± 1,231	1,259 ± 1,818	1,047 ± 1,096
Congestive heart failure	221 (18.3)	34 (21.9)	17 (21.8)
Ventricular arrhythmias	89 (7.4)	15 (9.7)	11 (14.1)
Heart block (Mobitz II or 3rd degree)	29 (2.4)	5 (3.2)	2 (2.6)
Unable to perform exercise test	324 (26.8)	27 (17.4)	24 (30.8)
Cardiac catheterization			
During initial hospital period	420 (34.8)	56 (36.1)	35 (44.9)
30 days	503 (41.6)	67 (43.2)	37 (47.4)
180 days	528 (43.7)	74 (47.7)	38 (48.7)
Coronary revascularization			
PTCA			
Initial hospital period	68 (5.6)	5 (3.2)	6 (7.7)
180 days	151 (12.5)	19 (12.3)	19 (24.4)†
CABG			
Initial hospital period	149 (12.3)	15 (9.7)	12 (15.4)
180 days	156 (12.9)	15 (9.7)	12 (15.4)
Outcome			
Hospital mortality	139 (11.5)	14 (9.0)	11 (14.1)
30-day mortality	162 (13.4)	14 (9.0)	13 (16.7)
180-day mortality	184 (15.2)	17 (11.0)	13 (16.7)
Hospital readmission (within 180 days)	51 (4.2)	5 (3.2)	3 (3.8)

*$p < 0.001$. †$p < 0.01$. Data presented are mean ± SD or number (%) of patients. CABG = coronary artery bypass graft surgery; PTCA = percutaneous transluminal coronary angioplasty.

complete outcome data beyond that available through the CEPRP, our dataset was linked using unique patient identifiers to the Retrospective Case Mix Analysis System (a Department of Defense information system similar to the Medicare Part A files) to identify all readmissions and invasive cardiac procedures performed within 180 days of the index admission. Included in these data are procedures and admissions at both military health care and civilian facilities through the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS). Late deaths (within 180 days) were identified through the Defense Eligibility and Enrollment Registration System. No patient was lost to administrative follow-up through these databases.

Statistical analysis. The chi-square test with Yates correction was used to evaluate the relation of ethnicity to individual patient variables, interventions and outcomes. The two-tailed *t* test was used to analyze for differences in continuous variables (age and peak CK). To control for multiple variables simultaneously, logistic regression analysis was used to estimate odds ratios for the role of ethnicity in the use of invasive cardiac procedures and its effect on outcome controlling for potential confounders. Multivariate stepwise analysis was performed with the end points of this study (cardiac catheterization, coronary revascularization and mortality) as dependent variables and race as the independent variable of interest. Our models treated risk factors for coronary artery disease (age, gender, diabetes, hypertension, hypercholesterolemia, smoking and previous AMI), clinical factors (use of thrombolytic agents, ST segment elevation on presentation, congestive heart failure, heart block, performance of stress testing and CK levels) and socioeconomic characteristics (beneficiary category and military rank) as independent variables. We considered a two-tailed p value of 0.05 to be statistically significant. All analyses were performed with the STATA statistical package (STATA v.4, STATA, College Station, Texas).

Results

Patient data. Overall, 1,441 patients with a confirmed AMI (1,208 white, 233 nonwhite [155 black, 78 of nonblack ethnic origin]) were identified during the study period. The mean [±SD] patient age was 62.4 ± 11.4 years, and 73.4% of the study cohort was male. Baseline characteristics of the study cohort are indicated in Table 1. Overall, white and nonwhite

patients were comparable with respect to the prevalence of diabetes mellitus, hypercholesterolemia, tobacco use and previous AMI. However, white patients were older than both black patients and patients of nonblack ethnic origin (63.1 ± 11.1 vs. 57.7 ± 12.7 and 60.6 ± 12.1 years, respectively, $p < 0.001$ for both comparisons). Black patients were significantly more likely than white patients to have hypertension (67.1% vs. 45.5%, $p < 0.001$).

Cardiac catheterization. During the index admission for AMI, univariate comparisons indicated that cardiac catheterization was performed in 34.8% of white patients, 36.1% of black patients and 44.9% of patients of nonblack ethnic origin (p = NS for all comparisons vs. white race). These nonsignificant differences were diminished by 180 days, by which 43.7% of white patients, 47.7% of black patients and 48.7% of patients of nonblack ethnic origin had undergone cardiac catheterization (p = NS for all comparisons). Logistic regression was performed to control for multiple patient and AMI variables that might have influenced the rates of cardiac catheterization. The estimated odds ratios for cardiac catheterization up to 180 days after the index AMI for white versus nonwhite patients, white versus black patients and white versus nonblack ethnic patients are displayed in Table 2. For comparisons of white and nonwhite patients, the estimated odds ratios for the influence of ethnicity on rates of cardiac catheterization were near 1 for both catheterization during the initial hospital period (odds ratio [OR] 0.96, 95% confidence interval [CI] 0.69 to 1.34, p = 0.83) and cumulatively up to 180 days after AMI (OR 1.07, 95% CI 0.77 to 1.49, p = 0.67). As indicated, although the estimated odds ratio estimates were comparable for subgroup comparisons of white patients with black and nonblack ethnic patients, small sample sizes limit the precision of these estimates.

Factors related to the use of cardiac catheterization were explored (Fig. 1). An increased likelihood of cardiac catheterization during the initial hospital period was related to ST segment elevation on the admission electrocardiogram (OR 1.31, 95% CI 1.00 to 1.72, p = 0.047), having undergone an exercise tolerance test after AMI (OR 2.50, 95% CI 1.94 to 3.23, $p < 0.001$), the presence of hypercholesterolemia (OR 1.51, 95% CI 1.13 to 2.01, p = 0.005) and higher peak CK value (OR 1.03 per 250 U/liter increment in peak CK value, 95% CI 1.01 to 1.05, p = 0.03). Conversely, the estimated odds ratios related to smoking (OR 0.62, 95% CI 0.39 to 0.98, p = 0.04) and the presence of congestive heart failure (OR 0.57, 95% CI 0.40 to 0.80, p = 0.001) indicated that cardiac catheterization was significantly less likely under these circumstances.

Although the rates of utilization of cardiac catheterization were similar in white and nonwhite patients, data were collected from abstracted charts according to whether catheterization was being "considered" in the future. Overall, 348 such patients were identified, with a tendency for this designation to be found more commonly in white than nonwhite patients (25.0% vs. 19.8%, p = 0.09). After controlling for multiple patient and AMI variables, the estimated odds ratio for "consider cath" in white versus nonwhite patients was 1.77 (95% CI 1.20 to 2.61, p = 0.003). Comparable estimated odds ratios were observed for subgroup comparisons of white with black and nonblack ethnic patients. However, although white patients were "considered" for cardiac catheterization more frequently, subsequent catheterization in the 180 days after hospital discharge in this subgroup of patients was infrequently performed (n = 87 [25.0%]) and late mortality (within 180 days) in this subgroup was uncommon (n = 15 [4.3%]).

Table 2. Estimated Odds Ratios for Cardiac Catheterization and Coronary Revascularization According to Ethnic Group in Patients with Acute Myocardial Infarction in the Civilian External Peer Review Program

Outcome	Estimated OR* (95% CI)	p Value
Cardiac catheterization		
White vs. nonwhite pts		
Initial hosp	0.96 (0.69–1.34)	0.83
Within 180 days	1.07 (0.77–1.49)	0.67
White vs. black pts		
Initial hosp	1.19 (0.80–1.78)	0.39
Within 180 days	1.20 (0.81–1.78)	0.35
White vs. nonblack ethnic pts		
Initial hosp	0.67 (0.40–1.12)	0.13
Within 180 days	0.89 (0.53–1.50)	0.65
Revascularization within 180 days		
White vs. nonwhite pts		
Any revasc	0.90 (0.59–1.39)	0.65
PTCA	0.84 (0.51–1.38)	0.49
CABG	1.28 (0.75–2.16)	0.38
White vs. black pts		
Any revasc	1.11 (0.65–1.89)	0.72
PTCA	1.11 (0.59–2.1)	0.74
CABG	1.48 (0.75–2.93)	0.26
White vs. nonblack ethnic pts		
Any revasc	0.66 (0.34–1.26)	0.21
PTCA	0.56 (0.27–1.17)	0.12
CABG	1.01 (0.46–2.21)	0.98

*Estimated odds ratios were derived by multiple logistic regression, with each ratio adjusted for patient demographic and acute myocardial infarction variables (see Methods). An estimated odds ratio <1 indicates that a white patient was less likely to experience the indicated outcome than a nonwhite patient with the same characteristics, and a ratio >1 indicates that white patients had a higher odds. CI = confidence interval; hosp = hospital period; OR = odds ratio; pts = patients; revasc = revascularization; other abbreviations as in Table 1.

Coronary revascularization procedures. PTCA was performed during the initial hospital period at a comparable rate in all three racial groups (Table 1). However, patients of nonblack ethnic origin underwent late PTCA significantly more frequently than white patients (24.4% vs. 12.5%, p = 0.003). PTCA was comparably performed in white and black patients (12.5% vs. 12.3%, respectively, p = 0.93). There were no significant differences between white and nonwhite patients in frequency of CABG. Logistic regression was performed to control for multiple patient and AMI variables that might have influenced the use of revascularization procedures in white versus nonwhite patients and white versus black patients (Table 2). The estimated odds ratio for the influence of white

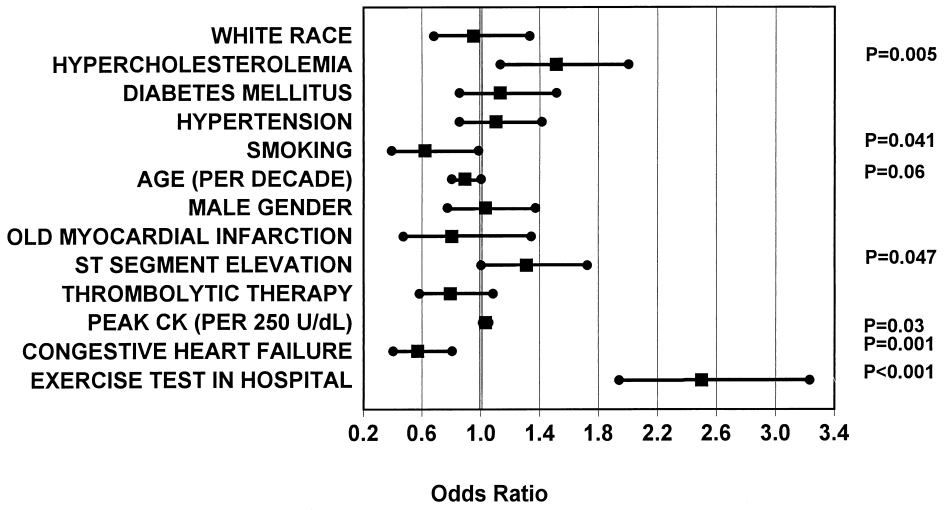

Figure 1. Estimated odds ratios (**squares**) and 95% confidence intervals (**horizontal bars**) for cardiac catheterization during the index AMI admission according to various patient characteristics. Estimated odds ratios as indicated are adjusted for other variables (see Methods).

versus black race on the use of any revascularization procedure performed within 180 days of AMI was 1.11 (95% CI 0.65 to 1.89, p = 0.72). The limited numbers of these procedures in nonblack ethnic patients limit the precision of the estimated odds ratios for revascularization in this group.

Outcome data. Outcomes measured by mortality and hospital readmissions were also analyzed (Tables 1 and 3). Mortality rates were slightly higher in white versus nonwhite patients, both in-hospital (11.5% vs. 10.7%, p = 0.73) and at 180 days after AMI (15.2% vs. 12.9%, p = 0.36), but these differences were not statistically significant. Similarly, 180-day hospital readmission rates were comparable in both groups (white patients 4.2%, nonwhite patients 3.4%, p = 0.58). Multiple regression analysis found no significant relation between ethnic group and 30-day mortality, as well as mortality and readmissions at 180 days, after controlling for cardiac risk factors and AMI variables.

Role of military status and rank as a surrogate of income. Separate analyses were performed for rates of procedural and outcome variables according to military status and rank, as an index of income. In no case was military status or rank a significant contributor to the logit models.

Discussion

Previous data on the impact of race on access to cardiovascular procedures have been consistent in the finding of bias against nonwhite patients; thus, the existence of a "racial" bias is generally accepted. Past studies have indicated that the odds ratio for cardiac catheterization in a white patient with suspected ischemic heart disease is ~1.4 times greater than in a nonwhite patient, although some reports (1,2) have found the odds ratios to be as high as 2. Similar, if not greater, degrees of disparity have been found in access to other cardiovascular procedures, such as PTCA or CABG (1,14). Despite these results, separating race from other factors has proved difficult. The separation of race from socioeconomic status has relied on analyses from health care systems possessing distinct characteristics, such as the VAMS, yet such data are often limited by the depth of clinical information contained or by other factors.

The present study. Our extensive administrative and clinical data indicate that within the MHSS, where access to medical care and procedures is equal and ensured as a right of beneficiary status, and socioeconomic differences between patients are minimized, the utilization of invasive cardiac procedures and outcome after AMI is determined by clinical variables exclusive of race. We did identify an increased likelihood of white patients to be "considered" for catheterization more frequently than nonwhite patients, suggesting

Table 3. Estimated Odds Ratios for Outcome Variables According to Ethnic Group in Patients with Acute Myocardial Infarction in the Civilian External Peer Review Program

Outcome	Estimated OR* (95% CI)	p Value
White vs. nonwhite pts		
Mortality		
30 days	0.91 (0.51–1.66)	0.77
180 days	0.99 (0.57–1.74)	0.99
Hospital readmission within 180 days	1.05 (0.48–2.29)	0.91
White vs. black pts		
Mortality		
30 days	1.04 (0.47–2.27)	0.93
180 days	1.04 (0.51–2.12)	0.92
Hospital readmission within 180 days	1.02 (0.39–2.7)	0.96
White vs. nonblack ethnic pts		
Mortality		
30 days	0.76 (0.32–1.80)	0.53
180 days	0.92 (0.39–2.13)	0.84
Hospital readmission within 180 days	1.04 (0.40–2.72)	0.94

*Estimated odds ratios were derived by multiple logistic regression, with each ratio adjusted for patient demographic and acute myocardial infarction variables (see Methods). An estimated odds ratio <1 indicates that a white patient was less likely to experience the indicated outcome than a nonwhite patient with the same characteristics, and a ratio >1 indicates that white patients had a higher odds. Abbreviations as in Table 2.

that within the physician/patient interaction, a differential association with race is discernible. However, in this low risk group few patients actually underwent subsequent cardiac catheterization, indicating that the overriding determinant of the utilization of cardiac catheterization was the clinical status of the patient and not race. In contrast to data from the Myocardial Infarction Triage and Interventional Registry (14), in which nonwhite patients had lower rates of coronary revascularization despite similar rates of cardiac catheterization, we did not observe an association of race and the use of coronary revascularization procedures. The finding that socioeconomic status as measured by military rank had no effect on our models confirms the absence of significant socioeconomic barriers to care in our population.

Origins and solutions for ethnic bias in access to cardiovascular procedures. The etiology of the previously observed differences between white and nonwhite patients in access to cardiovascular procedures is unknown and controversial, with the possibility that the differences have a racial etiology at the center of the issue. In particular, the isolation of race from socioeconomic status has proved difficult. Studies from the VAMS and Medicare have attempted to do this by evaluating the impact of race within the relatively socioeconomically homogeneous populations they serve. Data from the VAMS (7), a system postulated to overcome many of the above limitations, particularly those related to socioeconomic status, access to care and financial motives, indicated a nearly twofold increase in the rate of cardiac catheterization for white versus black patients with a primary diagnosis of cardiovascular disease or chest pain. However, the strength of the conclusion that this difference is solely attributable to race remains limited because the VAMS is not completely free of access barriers, such as geographic separation, to care and medications. These data also may be limited in their generalizability because the VAMS serves a higher proportion of poor and indigent patients than the civilian health care system. Nonetheless, other recent data (9) on the use of health services by Medicare beneficiaries supports a racial bias in the use of elective coronary revascularization procedures. This bias was reduced, but not corrected, by a broad adjustment for income level.

A further limitation to the above conclusions derived from largely administrative databases comes from the lack of relevant clinical information on which they are based. In an effort to address this limitation, a recent report from Peterson et al. (11) reported persistence of racial differences in use of cardiovascular procedures after broad correction for clinical characteristics, yet adjustments for socioeconomic differences were not made in their study.

Our study cannot isolate the responsible factors that eliminated ethnic bias in our study sample. Specific factors may include the absence of financial barriers to accessing the health care system, the absence of provider financial incentives and relative socioeconomic parity among patients. However, perhaps the most important lesson from our data is not the specific characteristics or factors that relate to the use of cardiac catheterization after AMI, but rather the characteristics of a health care system in which ethnic inequities in access to health services are eliminated.

Many of the characteristics of the MHSS are those found within systems of managed care. The MHSS can be characterized as a large, nationwide, staff-model managed care plan with some financial barriers, such as CHAMPUS co-pays, to accessing providers outside the system. Furthermore, the MHSS is globally budgeted and is indefinitely "at risk" from both a financial and resource utilization standpoint for the outcomes of its beneficiaries. Thus, the "system" may act to minimize ethnic differences in health care utilization in that the system's interests are best served by taking the best care of its beneficiaries. Admittedly, differences between the MHSS and health maintenance organizations do exist and include the cultural influence of rank in a military organization. Health maintenance organizations are also subject to pressures under the motive of profitability of the system and are more likely to experience a high degree of beneficiary turnover. Thus, this hypothesis, that a health care system such as a health maintenance organization possesses characteristics that could limit ethnic inequities in access to health services, is deserving of future study. Promise for this hypothesis is found in recent data (15) from the Kaiser Permanente Medical Care Program demonstrating that a health care system can exert a positive influence to reduce the variability between hospitals in procedural utilization after AMI.

Limitations of the study. Our detailed abstracted chart review data had the advantage of containing accurate clinical information, enabling us to control for AMI severity by considering data such as peak CK level and the presence of congestive heart failure or ventricular arrhythmias, known markers of increased risk after AMI. Although this represents an improvement over most previous studies on racial bias in cardiovascular procedures that have relied primarily on administrative data, other prognostic measures, such as left ventricular ejection fraction, were not available. However, outcomes over 180 days, a period of time relevant to heightened risk after AMI (16,17), were comparable among patient groups. Despite comparable outcomes with respect to "hard" events (death and readmission), it is unknown whether other outcomes such as frequency of angina, functional status or quality of life were comparable. Furthermore, these data are relevant to the issue of racial bias in access to invasive cardiovascular procedures. Although such procedures are readily identifiable and therefore lend themselves to study, they represent just a single patient management decision. Thus, the absence of racial bias throughout the entirety of the patient/physician interaction cannot be assumed.

Our study is relatively small compared with previously reported experience from administrative databases. However, post hoc analysis indicated that our sample had a power of 0.85 (beta 0.15) to detect an odds ratio for in-hospital catheterization between white and nonwhite patients of 1.3 and a power of 0.96 (beta 0.04) for a similar difference in 180-day catheterization. Alternatively, attention to the 95% confidence intervals (18) of the estimated odds ratio indicates that, for 180-day cardiac catheterization, the data are consistent with a "true" odds ratio of

between 0.77 and 1.49. Thus, our sample had sufficient power to detect a difference comparable to that previously described in the utilization rates of cardiac catheterization (1,2). Broader confidence intervals are seen in our subgroup comparisons of white versus black and nonblack ethnic patients. Thus, caution is advised in the interpretation of these results. Future studies including larger numbers of patients, particularly nonblack ethnic patients, would be helpful in this regard. Furthermore, future studies would be improved by the analysis of ethnic differences in the use of cardiovascular procedures in diagnostic groups other than AMI, such as angina pectoris, as recently performed by Peterson et al. (11). The possible effect of selection bias should be minimized because the study included all patients with a primary or secondary diagnosis of AMI during the predefined sampling period.

One concern with the use of MHSS data for health services research centers on the issue of generalizability. With respect to age and race, these patients were similar to adults (>21 years old) with AMIs in the 1990 National Hospital Discharge Survey (NHDS) (19). In that population, the mean age was 62.9 ± 18.0 years (range 22 to 99+), 84.1% were white, 13.2% were black, and 2.7% were of other race. However, in the NHDS, only 42.9% were men, significantly less than we found in the MHSS data ($p < 0.01$). To address this discrepancy, we adjusted our models for any potential effect of gender. The general processes of care in MHSS and civilian hospitals are also similar. A review of the distribution of diagnosis-related groups (DRGs) in the two health systems reveals that the relative ranks of the 420 most common DRGs are comparable (Spearman's rho 0.71). Finally, although the rate of cardiac catheterization observed in the present study (35.5% during the initial hospital period and 44.4% by 180 days) is higher than that reported from the VAMS (7), these data are consistent with data from patients assigned to conservative management after AMI, as reported in the second Thrombolysis in Myocardial Infarction Trial (17).

Conclusions. Both physician vigilance and patient education should be essential measures toward ensuring that medical appropriateness is the sole determinant of access to health care. With recent studies indicating a lack of progress in the advancement of ethnic parity in access to cardiovascular procedures despite 20 years of education of health care workers and patients on this important societal issue, the time may have arrived for health care systems to participate in solving this problem. Our data, which require confirmation in larger studies, raise the promise that characteristics of a health care system can mitigate the pervasive tendency toward ethnic inequity in medicine.

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References

1. Ford E, Cooper R, Castaner A, Simmons B, Mar M. Coronary arteriography and coronary bypass survey among whites and other racial groups relative to hospital-based incidence rates for coronary artery disease: findings from NHDS. Am J Public Health 1989;79:437–40.
2. Franks AL, May DS, Wenger NK, Blount SB, Eaker ED. Racial differences in the use of invasive coronary procedures after acute myocardial infarction in Medicare beneficiaries. Ethn Dis 1993;3:213–20.
3. Gillum RF. Coronary artery bypass surgery and coronary angiography in the United States, 1979–1983. Am Heart J 1987;113:1255–60.
4. Hannan EL, Kilburn H Jr, O'Donnell JF, Lukacik G, Shields EP. Interracial access to selected cardiac procedures for patients hospitalized with coronary artery disease in New York State. Med Care 1991;29:430–41.
5. Oberman A, Cutter G. Issues in the natural history and treatment of coronary heart disease in black populations: surgical treatment. Am Heart J 1984;108:688–94.
6. Wenneker MB, Epstein AM. Racial inequalities in the use of procedures for patients with ischemic heart disease in Massachusetts. JAMA 1989;261: 253–7.
7. Whittle J, Conigliaro J, Good CB, Lofgren RP. Racial differences in the use of invasive cardiovascular procedures in the Department of Veterans Affairs Medical System. N Engl J Med 1993;329:621–7.
8. Stone PH, Thompson B, Anderson HV, et al. Influence of race, sex, and age on management of unstable angina and non-Q-wave myocardial infarction: the TIMI III registry. JAMA 1996;275:1104–12.
9. Gornick ME, Eggers PW, Reilly TW, et al. Effects of race and income on mortality and use of services among Medicare beneficiaries. N Engl J Med 1996;335:791–9.
10. Giles WH, Anda RF, Casper ML, Escobedo LG, Taylor HA. Race and sex differences in rates of invasive cardiac procedures in US hospitals: data from the National Hospital Discharge Survey. Arch Intern Med 1995;155:318–24.
11. Peterson ED, Shaw LK, DeLong ER, Pryor DB, Califf RM, Mark DB. Racial variation in the use of coronary-revascularization procedures. Are the differences real? Do they matter? N Engl J Med 1997;336:480–6.
12. Ford ES, Cooper RS. Racial/ethnic differences in health care utilization of cardiovascular procedures: a review of the evidence. Health Serv Res 1995;30:237–52.
13. Mayer W, Clinton JJ, Newhall D. A first report of the Department of Defense external civilian peer review of medical care. JAMA 1988;260: 2690–3.
14. Maynard C, Litwin PE, Martin JS, et al. Characteristics of black patients admitted to coronary care units in metropolitan Seattle: results from the Myocardial Infarction Triage and Intervention Registry (MITI). Am J Cardiol 1991;67:18–23.
15. Sherwood M, Fireman BH, Lundstrom RJ, et al. Variation among hospitals in coronary angiography practices and outcomes after myocardial infarction in a large health maintenance organization. N Engl J Med 1996;335:1888–96.
16. Terrin ML, Williams DO, Kleiman NS, et al. Two- and three-year results of the Thrombolysis in Myocardial Infarction (TIMI) Phase II clinical trial. J Am Coll Cardiol 1993;22:1763–72.
17. Rogers WJ, Babb JD, Baim DS, et al. Selective versus routine predischarge coronary arteriography after therapy with recombinant tissue-type plasminogen activator, heparin and aspirin for acute myocardial infarction: TIMI II Investigators. J Am Coll Cardiol 1991;17:1007–16.
18. Goodman SN, Berlin JA. The use of predicted confidence intervals when planning experiments and the misuse of power when interpreting results. Ann Intern Med 1994;121:200–6.
19. National Center for Health Statistics. 1990 National Hospital Discharge Survey: CD-ROM series 13. Hyattsville, MD: National Center for Health Statistics, 1993.